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PATENT APPLICATION

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IN THE  
UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s): Randy Hoffman et al.

Confirmation No.: 7102

Application No.: 10/763,353

Examiner: Johannes P. Mondt

Filing Date: January 23, 2004

Group Art Unit: 3663

Title: Semiconductor Device

Mail Stop Appeal Brief - Patents  
Commissioner For Patents  
PO Box 1450  
Alexandria, VA 22313-1450

TRANSMITTAL OF REPLY BRIEF

Transmitted herewith is the Reply Brief with respect to the Examiner's Answer mailed on 05/26/2010.

This Reply Brief is being filed pursuant to 37 CFR 1.193(b) within two months of the date of the Examiner's Answer.

(Note: Extensions of time are not allowed under 37 CFR 1.136(a))

(Note: Failure to file a Reply Brief will result in dismissal of the Appeal as to the claims made subject to an expressly stated new ground rejection.)

No fee is required for filing of this Reply Brief.

If any fees are required please charge Deposit Account 08-2025.

Respectfully submitted,

Randy Hoffman et al.

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**REPLY BRIEF**

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Sir:

This is a Reply Brief under Rule 41.41 (37 C.F.R) in response to the Examiner's Answer of May 15, 2009 (the "Examiner's Answer" or the "Answer"). In Section 10, the Answer contains a response to some of the arguments made in Appellant's brief. Appellant now responds to the Examiner's Answer as follows.

**Status of Claims**

The status of the claims in unchanged by the Answer.

Claims 1-3, 5, 10, 13, 16-18, 20-25, 27-30, 40-47, 49, 51-53, 56-59, 61-63, and 65-67 were cancelled previously without prejudice or disclaimer. Thus, claims 4, 6-9, 11, 12, 14, 15, 19, 26, 31-39, 48, 50, 54, 55, 60, and 64 are pending in the present application and stand finally rejected. Accordingly, Appellant appeals from the final rejection of claims 4, 6-9, 11, 12, 14, 15, 19, 26, 31-39, 48, 50, 54, 55, 60, and 64.

**Grounds of Rejection to be Reviewed on Appeal**

The grounds of rejection under appeal are unchanged by the Answer.

The final Office Action raised the following grounds of rejection.

- (1) Claims 4, 6-9, 11, 26, 31-36, 48, 50, 54, 55, and 60 were rejected under 35 U.S.C. §102(e) as allegedly being anticipated by U.S. Patent App. Pub. No. 2004/0127038 to Carcia et al. (“Carcia”).
- (2) Claim 19 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia and U.S. Patent No. 4,521,698 to Taylor (“Taylor”).
- (3) Claim 12 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia and U.S. Patent No. 6,674,495 to Hong et al. (“Hong”).
- (4) Claims 14 and 38 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia and U.S. Patent No. (6,100,558) to Krivokapic et al. (“Krivokapic”).
- (5) Claims 15 and 39 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia, Krivokapic and U.S. Patent App. Pub. No. 2004/0169210 to Hornik et al. (“Hornik”).
- (6) Claim 64 was rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Carcia and U.S. Patent No. 5,744,864 to Cillessen et al. (“Cillessen”) and U.S. Patent No. (6,184,946) to Ando et al. (“Ando”).
- (7) Claims 4, 7-9, 12, 19, 26, 32-35, 37, 48, 50, 54, 55, 60 and 64 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Cillessen.

(8) Claims 6, 11, 31 and 36 were rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over the combined teachings of Cillessen and Carcia.

Accordingly, Appellant hereby requests review of each of these grounds of rejection in the present appeal.

**Argument**

(1) Claims 4, 6-9, 11, 26, 31-36, 48 and 50, 54, 55, 60 are patentable over Carcia.

**Independent claims 4, 48, 50 and 60:**

For convenience, claim 4 is reproduced again here as representative of these independent claims at issue. Claim 4 recites:

A semiconductor device, comprising:  
a source electrode;  
a drain electrode;  
*a channel coupled to the source electrode and the drain electrode and comprised of a ternary compound containing zinc, tin and oxygen, where at least a portion of the channel is formed from a zinc-tin oxide compound having the following stoichiometry:  $Zn_2SnO_4$ ;* and  
a gate electrode configured to permit application of an electric field to the channel.

(Emphasis added)

Independent claims 4, 48, 50, and 60 all recite, *inter alia*, a channel which comprises a zinc-tin oxide. The final Office Action, in a §102 rejection, asserts that Carcia, in paragraph 0010, teaches a channel comprised “ternary compound containing zinc, tin and oxygen.” (Action, p. 2). Paragraph 0010 of Carcia is reproduced below, in relevant part.

This invention relates to novel, transparent oxide semiconductor (TOS) thin film transistors (TFT's) and the process for their deposition, where the transparent oxide semiconductor (TOS) is selected from the group consisting of zinc oxide (ZnO), indium oxide (In<sub>2</sub>O<sub>3</sub>), tin oxide (SnO<sub>2</sub>), or cadmium oxide (CdO) semiconductor and combinations thereof.

**The Final Action erred in citing paragraph 0010 of Carcia against the present application because the subject matter of paragraph 0010 is not prior art.**

The Appellant notes that the present application claims priority to a provisional application, serial number 60/490,239 which was filed on July 25, 2003 (hereafter “Hoffman

provisional”). Garcia was filed well after that date on Sept. 24, 2003, but claims priority to an earlier provisional application, serial number 60/417,767 (hereinafter “Garcia provisional”) which was filed Oct. 11, 2002. Consequently, **only subject matter within Garcia that was previously disclosed in the Garcia provisional is available as prior art against the present application.** As it turns out, this excludes paragraph 0010 of Garcia, on which the final Office Action relies, from being prior art.

The Garcia provisional is directed solely toward zinc oxide as a channel material. **The Garcia provisional is absolutely silent with regard to tin, any tin compound, or any combination of zinc oxide with tin.** As a result, Garcia is not a prior art for any teaching of “a channel layer formed *from a zinc-tin oxide material*,” (emphasis added) as recited in Appellant’s claims. For at least this reason, the rejection of Appellant’s claims based on Garcia cannot be sustained.

#### Rebuttal of Examiner’s Answer

The Examiner’s Answer argues that the Hoffman provisional does not contain the claimed subject matter and therefore does not provide the present application with an effective date which antedates Garcia. This is incorrect. The Hoffman provisional provides ample disclosure of “a channel layer formed from a zinc-tin oxide material.” For example, the title of the Hoffman provisional is “Transparent Thin-film Transistor with **Zinc-Tin Oxide Channel Layer.**” Additional support for a “channel layer formed from zinc-tin oxide material” is found in the Hoffman provisional, for example, in the Abstract, Summary of the Invention, page 6, and in claim 1.

As discussed above, the Garcia provisional is absolutely silent with regard to tin, any tin compound, or any combination of zinc oxide with tin. Consequently, the **Hoffman**

*provisional provides the present application with an effective date for this claimed subject matter which antedates* any disclosure of Garcia with respect to the recited “channel layer formed from a zinc-tin oxide material.”

Additionally, even if paragraph 0010 of Garcia were prior art against the present application, which it is not, Garcia still does not teach those of skill in the art that zinc-tin oxide is used as channel material. As discussed in the Appellant’s Appeal Brief, Garcia never discloses any ternary zinc-tin oxide or any other ternary compound. Second, one of skill in the art would **not** have understood “and combinations thereof” to include ternary zinc-tin oxide. Ternary compounds, particularly amorphous ternary compounds, were generally assumed by those of skill in the art to have poor electron mobility, rendering them unsuitable for transistor channels.

“A claim is anticipated [under 35 U.S.C. § 102] only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference.” *Verdegaal Bros. v. Union Oil Co. of California*, 2 U.S.P.Q.2d 1051, 1053 (Fed. Cir. 1987). See M.P.E.P. § 2131. As demonstrated here, the cited portions of Garcia are not prior art. Further, Garcia does not teach or suggest all the features of claims 4, 48, 50, and 60.

Additionally, “[t]he prior art reference—in order to anticipate under 35 U.S.C. § 102—must not only disclose all elements of the claim within the four corners of the document, but must also disclose those elements ‘arranged as in the claim.’” *NetMoneyIn v. Verisign*, (Fed. Cir. 2008) (quoting *Connell v. Sears, Roebuck & Co.*, 722 F.2d 1542 (Fed. Cir. 1983)). Garcia clearly fails to teach or suggest all the elements of claims 4, 48, 50 and 60 as arranged in those claims.

. Therefore, for at least the reasons explained here, the rejection based on 35 U.S.C. § 102(b) of claims 4, 48, 50, and 60 and their dependent claims should not be sustained.

(7) Claims 4, 7-9, 12, 19, 26, 32-35, 37, 48, 50, 54, 55, 60 and 64 are patentable over Cillessen.

Claims 4, 7-9, 12, 19, 26, 32-35, 37, 48, 50, 54, 55, 60 and 64 were alternatively rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Cillessen. As set forth above, independent claims 4, 19, 48, 60, and 64 recite “a zinc-tin oxide compound having the following stoichiometry:  $Zn_2SnO_4$ ” and independent claim 50 recites “a ternary compound containing zinc, tin, and oxygen having the stoichiometry:  $(ZnO)_j(SnO_2)_{1-j}$ , where  $j$  is between 0.05 and 0.95.” Cillessen fails to teach or suggest this subject matter.

The Examiner repeatedly refers to the following portion of Cillessen and asserts that this disclosure puts one of skill in the art in possession of the claimed subject matter.

It is also possible to use other covalent oxides of a non-transition metal provided with dopant atoms for the semiconductor material of the channel region 4. Oxides of these metals and mixtures of oxides of these metals have a mobility greater  $10 \text{ cm}^2/\text{V}\cdot\text{s}$  and a bandgap greater than 2.5 eV. For example,  $GeO_2$ ,  $SnO_2$ ,  $ZnO$ ,  $Bi_2O_3$ ,  $Sb_2O_3$ ,  $PbO$ ,  $GeO_2$ , or  $In_2O_2$ , mixtures of these oxides or compounds formed from these oxides such as  $GeInO_2$ ,  $ZnGa_2O_4$  or  $CdGa_2O_4$  may be used.

(Cillessen, col. 5, lines 34-43)

Thus, Cillessen provides a list of eight different binary compounds and states that “mixtures of these oxides or compounds formed from these oxides” may be used. (Cillessen, col. 5, lines 34-43). While zinc oxide and tin oxide are included amongst the list of eight different compounds, the number of possible combinations that could be created from the disclosed list is extremely large.

In the Appellant’s Appeal Brief, the Appellant included several illustrative lists of possible “***mixtures*** of these oxides or ***compounds*** formed from these oxides.” (Appeal Brief, p. 24-30). In total, the Appellant listed approximately 486 possible compounds which are illustrative of “***mixtures*** of these oxides or ***compounds*** formed from these oxides.”

Rebuttal of Examiner's Answer

The Examiner's Answer states that the listing given by the Appellant in the Appeal Brief "misrepresents" and "overestimate(s)" of the number of combinations of "combined compounds." The Appellant disagrees with the Examiner for a number of reasons discussed below.

As stated in the Appeal brief, the illustrative lists are a *serious underestimate* of the possible "*mixtures* of these oxides or *compounds* formed from these oxides" taught by Cillessen. A chemical mixture is "an aggregate of two or more substances that are not chemically united and that exist in no fixed proportion to each other." (*Dictionary.com Unabridged* (v 1.1). Random House, Inc. <http://dictionary.reference.com/browse/Mixture> (accessed: June 19, 2009). Mixtures may be either homogeneous or heterogeneous.

The Examiner conveniently ignores that Cillessen teaches *mixtures* of the oxides and focuses on arguing that there are a limited number of "combined compounds" which are operable due to "valence" conditions. (Examiner's Reply, p. 26). Ignoring that Cillessen teaches *mixtures* of the oxides is a misrepresentation of the art. One of ordinary skill in the art who read Cillessen would not know that the operable substance claimed by Appellant is a compound. Rather, the person of ordinary skill in the art would be faced with *all possible mixtures* and *all possible compounds* taught by Cillessen. To limit Cillessen's teaching to compounds, excluding mixtures, in an attempt to reach Appellant's claimed subject matter is clearly an exercise of impermissible hindsight on the part of the Examiner.

Mixtures are not limited by "valence" conditions and can be formed of any number of the eight disclosed oxides mixed in any proportion. The illustrative lists in the Appeal Brief include combinations containing only up to four oxides. Cillessen makes no such limitation. Consequently a complete listing of combinations taught by Cillessen would include additional

combinations of five, six, seven, and eight oxides. Further, a complete list would necessarily include all possible proportions of any of the eight oxides included in each mixture.

Further, a mixture which is heterogeneous does not have a uniform composition throughout the mixture. This gives rise to a number of structural, phase segregation, or other variations which further increases the number of possibilities faced by a person of ordinary skill in the art who is relying on the teachings of Cillessen.

The fact that there are a number of combinations which do not form chemical bonds due to molecular bonding constraints (as pointed out by the Examiner's Reply, p. 16) only complicates the inquiry by including inoperable embodiments. Further, a large number of the compounds, although chemically viable, may not have the performance characteristics desired to operate as a thin film transistor channel. This low likelihood of success, combined with the overwhelming number of "mixtures of these oxides" and "compounds formed from these oxides" does not teach or suggest to one of skill in the art that  $Zn_2SnO_4$  should be selected and is suitable for a channel in a transparent thin film transistor.

Clearly, as demonstrated above, the cited prior art did not enable the claimed invention or place those skilled in the art in possession of the invention, unless impermissible hindsight is invoked. Moreover, as mentioned above, the claimed invention is contrary to the generally accepted wisdom in the art. Ternary compounds, particularly amorphous ternary compounds, were generally understood to have poor electron mobility, rendering them unsuitable for transistor channels. (Appellant's specification, p. 2).

Under the analysis required by *Graham v. John Deere*, 383 U.S. 1 (1966) to support a rejection under § 103, the scope and content of the prior art must first be determined, followed by an assessment of the differences between the prior art and the claim at issue in *view of the ordinary skill in the art*. In the present case, the scope and content of the prior

art, as evidenced by Cillessen, does not teach or suggest to one of ordinary skill in the art “a zinc-tin oxide compound having the following stoichiometry:  $Zn_2SnO_4$ ” or a “ternary compound containing zinc, tin, and oxygen stoichiometry:  $(ZnO)_j(SnO_2)_{1-j}$ , where  $j$  is between 0.05 and 0.95.”

The differences between the cited prior art and the claimed subject matter are significant because ternary zinc-tin oxides used as channel layers provide unexpected electron mobility which results in superior performance as a channel layer in a transparent thin film transistor. Thus, the claimed subject matter provides features and advantages not known or available in the cited prior art. Consequently, the cited prior art will not support a rejection of 4, 19, 48, 50, 60, and 64 and their dependent claims under 35 U.S.C. § 103 and *Graham*.

As a final matter, the Appellant wishes to address the Examiner’s refusal to enter an after-final amendment filed by Appellant on October 28, 2008 (the “Amendment”), which seeks to correct a clear typographical error in claim 19. The Board of Appeals and Interferences previously remanded this application to the Examiner for failure to consider and dispose of the Amendment filed October 28, 2008. Accordingly, the Examiner has now formally, but improperly, refused entry to the Amendment.

By way of background, in preparing the Brief filed on October 30, 2008, Appellant noted that claim 19 contained a typographical error in that, in one instance, a gate electrode was specified when a drain electrode should have been recited. As will be explained below, this claim language is clearly a typographical error. Consequently, the after-final Amendment to correct this clear error was properly offered under 37 C.F.R. §41.33 and the provisions of 37 C.F.R. § 1.116 on October 28, 2008. However, the Examiner has refused to enter this amendment.

The amended version of claim 19, as contained in the Appellant's Amendment of October 28, 2008, is reproduced below.

Amended claim 19:

A three-port semiconductor device, comprising:  
a source electrode;  
a drain electrode;  
a gate electrode; and  
means for providing a channel disposed between the source electrode and drain electrode, the means for providing a channel configured to permit movement of electric charge therethrough, between the source electrode and the ~~gate~~ drain electrode in response to a voltage applied at the gate electrode, the means for providing a channel formed at least in part from a ternary compound containing zinc, tin and oxygen, where the means for providing a channel includes means for providing a semiconductor formed from a zinc-tin oxide compound having the following stoichiometry:  $Zn_2SnO_4$ .

It is clear to anyone of ordinary skill in the art that the error Appellant attempted to correct in this instance was purely typographical. For example, the Appellant's specification states that "the applied gate voltage controls the ability of the channel material to permit charge transport through the channel material between the other two electrodes (e.g., a source electrode and a drain electrode)." (Appellant's specification, p. 1, lines 21-23, parenthetical in the original). The Appellant's specification also states that "dielectric separates the gate" from the other electrodes and the channel (Appellant's specification, p. 3, lines 1-5), thereby preventing movement of any significant charge between the gate and the other electrodes. Further, the other claims correctly state that a dielectric material is disposed separating the gate electrode from the channel layer formed between the source and drain electrodes. (Claims 14, 38, 39, 55, 60). All this should make clear that claim 19 was intended to recite "a channel configured to permit movement of electric charge therethrough, between the source electrode and the drain electrode in response to a voltage applied at the gate electrode." (Claim 19) (emphasis added).

Additionally, the language of claim 19 standing alone makes it clear to one of skill in the art that the indicated error was purely typographical. Specifically, claim 19, as originally written, stated that "a means for providing a channel configured to permit movement of electric charge therethrough, between the source electrode and the *gate* electrode in response to a voltage applied at the *gate* electrode." (Original claim 19). *Clearly the gate electrode would not control electric charge through a channel and also receive the electrical charge which it controlled.* Again, this should make clear that the error in claim 19 was purely typographical and should be corrected.

Nevertheless, the Examiner has refused to enter Appellant's corrective amendment for non-substantive reasons. Specifically, the Examiner notes that he previously noted this issue to the Appellant in a non-final Office Action dated June 7, 2006. (Miscellaneous Action with SSP of September 16, 2009). Apparently, Appellant's representative failed to take any corrective action as to this issue in claim 19 at that time. The Examiner, apparently piqued that counsel did not then address the issue, now refuses to allow present counsel to do so.

The Appellant notes that the undersigned counsel was not engaged in this matter until mid-2008 and did not receive or respond to the non-final Office Action of June 7, 2006. While this error could have been addressed earlier, present counsel had no opportunity to do so. It seems inappropriate and unfair to refuse to correct a clear typographical error like the one at issue in claim 19 simply because previous counsel, no longer representing the Appellant in this matter, did not promptly respond as the Examiner desired. The undersigned counsel offered a corrective amendment to claim 19 as soon as aware of the typographical error.

This typographical error in claim 19 is not dispositive or substantive to any of the issues on appeal. Correction of the error would simply have placed the claim in better

condition for allowance and appeal. In any event, the Appellant requests that the Board note the corrected version of claim 19, notwithstanding the Examiner's refusal to enter the Amendment of October 28, 2008.

In view of the foregoing, it is submitted that the final rejection of the pending claims is improper and should not be sustained. Therefore, a reversal of the Rejection of June 2, 2008 is respectfully requested.

Respectfully submitted,

DATE: July 22, 2010

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